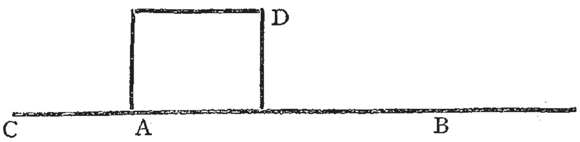
changes in the temperature of the dry air alone, is the object of the present paper. I commence with the diurnal variation.

Let us suppose an atmosphere of dry air hardly absorbing any heat from the solar rays, and therefore chiefly heated and cooled by contact with the earth. Let us take the moment when the earth first begins to be heated by the sun's rays. (This will probably take place a little before sunrise, in consequence of the large amount of reflected or diffused heat which accompanies the morning twilight.) The earth then becomes heated at A, while at B, a little more to the west, no heat is yet felt. The earth at A communicates its heat to the air in contact with it, and the latter expands and becomes lighter than the air in contact with the earth at B. (At C of course the earth is more highly heated than at A, and therefore the air in contact with the earth at C is still lighter.) The immediate consequence is that the heavier air at B rushes into the heated space A D (see fig.), driving out the lighter air which occupies it; and A D becoming filled with heavier air than before, the barometer at A rises. The heating goes on however at A, which remains at a higher temperature than B, until the epoch of greatest heat arrives; and consequently during all this time there is a flow of air from B towards A next the earth, with a flow in the contrary direction at a greater elevation. It might at first sight appear that the barometer at A would go on rising all this time. But a moment's reflection will show us that though it does so at first, it could not continue to do so all through. For as at the epoch of greatest cold (with which we commenced) C, A, and B were sensibly at the same temperature, so they will arrive at sensibly the same temperature at the epoch of greatest heat; and immediately afterwards the direction of the under-current will be reversed, C having become colder than A, while B is hotter. It is therefore evident that during the whole time which has elapsed between the epochs of greatest cold and greatest heat, the two currents will have counter-balanced each other, the under-current having carried exactly as much air from B to A as the upper-current has carried from A to B. Making a somewhat rough approximation, we may assume that during the first half of this period the under-current has been in excess, and the barometer at A has risen, while in the latter half the upper-current has been in excess, and the barometer at A has been falling. Immediately after the epoch of greatest heat, the cooler and heavier air at C will displace the air in the space A D, causing the barometer at A to rise. The moment of greatest heat will, therefore, correspond to a minimum reading of the barometer, not a maximum; and after it the barometer will go on rising until half way between it and the moment of greatest cold, when it will again fall until the latter moment. The barometer will, therefore, attain its minimum height at the hours of greatest heat and greatest cold, while the maximum heights will occur at about halfway between these epochs. Now this result appears to conform exactly to observation. It must be recollected that the minimum of temperature occurs not more than half an hour before sunrise, while the maximum is generally not reached for two or three hours after noon. This will explain why the morning barometric maximum seems to be nearly an hour earlier than the evening one. Indeed observation corresponds so exactly with the results arrived at, that I think it will appear that they cannot be seriously modified by the presence of aqueous vapour.



The mean of barometric pressures at different latitudes confirms these results. If the trade-winds extended to the poles—which they probably would do were it not that the parallels of latitude become so narrow before reaching them—on the same principles we might expect a minimum of pressure at the equator and the poles with a maximum at a latitude of about 45°. For the second of these minima we must evidently substitute the limit of the trades, or rather perhaps of the anti-trades, since the latter seem ultimately to become the under-currents; and our maximum will be situated about halfway between this limit and the equator. This agrees with observation. The phenomena of the tides too are analogous. There is low water where the moon's attraction is strongest and where it is feeblest, while high water corresponds to the mean attraction. Putting heat for attraction and the sun for the moon, the diurnal variations of the barometer follow the same law.

This law, however, does not appear to hold so well for the annual barometric changes. We can hardly trace in this case a double maximum in May and November, with minima in January and July. I think, however, that this result may be in part at least explained by the northern and southern shifting of the system of trades and anti-trades. For example, if a place in the northern hemisphere be near this limit (which corresponds to a minimum), the southern movement of the system in winter may cause the barometer to rise instead of falling as we approach the coldest day (supposing of course that it lies to the north of it). On the other hand, at a locality a little to the south of the limit, the northern movement of the system in summer may cause the barometer to rise at the time of greatest heat. I should perhaps notice, however, that the results here arrived at suppose the three points A, B, C to be situated on a horizontal plane, and the specific heat and conductibility of the earth at each of these points to be nearly identical. Hence they cannot be expected to hold for very elevated positions, or for places situated on the sea coast, or the shores of a large lake. They will be found most accurate in the interior of continents, where the land is level, and where the amount of aqueous vapour in the air is comparatively small. This anticipation is also verified by observation, so far as my knowledge reaches. W. H. S. MONCK

*REMARKS ON THE ADAPTIVE COLOURATION OF MOLLUSCA**

NATURALISTS have long recognised the curious cases oftentimes occurring, of the resemblance between the colour of an animal and its immediate surroundings. It had been supposed that climatic influences, or peculiarities of food, or greater or less access to light, had something to do with these coincidences. Mr. Alfred R. Wallace has shown that the varied phases of these phenomena could not be explained by such agents, and in a paper "On Mimicry and other protective resemblances among Animals," published in the *Westminster Review*, July 1867, and since made widely public in his work on "Natural Selection," he shows that the singular resemblances between the colour of animals and their surroundings are mainly brought about by the protection afforded them through greater concealment. Many very interesting examples are then cited from the Vertebrates and Articulates in support of these views. Briefly may be mentioned, as examples, the almost universal sand colour of those animals inhabiting desert tracts; the white colour of those animals living amid perpetual snows; the resemblance seen again and again between the colour of many insects and the places they frequent. Among the hosts of examples cited by Mr. Wallace as illustrating plainly the views he advances, may be mentioned the many species of Cicindela, or tiger beetle. The common English species, "*C. campestris*, frequents grassy banks, and is of a beautiful green colour, while *C. maritima*, which is found only on sandy sea shores, is of a pale bronzy yellow, so as to be almost invisible." He then states that a great number of species found by himself in the Malay Archipelago were similarly protected. "The beautiful *Cicindela gloriosa*, of a deep velvety green colour, was only taken upon wet mossy stones in the bed of a mountain stream, where it was with difficulty detected. A large brown species (*C. heros*) was found chiefly on dead leaves in forest paths; and one which was never seen except on the wet mud of salt marshes, was of a glossy olive so exactly the colour of the mud as only to be distinguished when the sun shone, by its shadow. Where the sand beach was coralline and nearly white, I found a very pale *Cicindela*; wherever it was volcanic and black, a dark species of the same genus was sure to be met with."

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* From the Proceedings of the Boston Society of Natural History, vol. xiv., April 5, 1871.

But little attention has been given to adaptive colouring among the lower invertebrate animals. Darwin, in his last work on the "Descent of Man," calls attention to the statements of Haeckel that the transparency of the Medusæ and other floating animals is protective, since their glass-like appearance renders them invisible to their enemies, though Wallace also alludes to this same feature (p. 258). Mr. Edward Burgess informs me of a species of Acaleph, *Polyclonia frondosa*, on the coast of Florida which lives in the mud, and is brown in colour. Darwin, while admitting that the transparency of these animals unquestionably aids them to escape the notice of their enemies, yet doubts whether the colour of mollusks affords similar protection. He says, "The colours do not appear in most cases to be of any use as a protection; they are probably the direct result, as in the lower classes, of the nature of the tissues, the patterns and sculpture of the shell depending on its manner of growth" (vol. i. p. 316)

In glancing over our New England Mollusca, however, it seems that we do have very clear evidences of protective adaptations among them, not only in their form, but more particularly in their colour. It would seem strange indeed if this were not so, since so many species of Mollusca form an important portion of the food of many fishes,* and also of certain species of birds.

In a general way, we recall the sombre colours of the shells of most species, varying through different shades of yellow, brown, and green, in this respect resembling the sand, mud, and rocks, or seaweed, in or upon which they live, and we then recall by groups the land snails of our woods, with their almost uniform brown tints, like the dead leaves or rotten wood in which they live.

The freshwater snails have similar shades to match their peculiar habitats.

The freshwater mussels, coloured likewise brown, greenish, or black, accord with their places of refuge.

Among the marine forms we notice the adaptive colouration of certain species very well marked. The common *Littorina* of the coast swarms on the bladder weed, the bulbous portions of which are olive brown in colour, or yellowish, according to age. The shells of the *Littorina* found upon it, present in their varieties these two colours, and are limited to these colours, though now and then delicately banded specimens are seen.

Purpura lapillus, which generally hides beneath overhanging ledges, or is concealed under flat rocks, has generally a dirty white shell, with, now and then, a specimen bright yellow, or banded with brown. We are not aware of any fish that feeds upon this species, though in the almost universal white colour of the species an adaptive colour may be secured in resembling the white barnacles which oftentimes whiten the rocks by their numbers.

In pools left at low tide where the rocks are often clothed with the red calcareous algæ we find the little red Chiton. Certain *Mytili* are green. The young of the large *M. modiolus* has a rough coat of epidermal filaments, looking like the aborescent growth of some Alga or Hydroid.

The few species common to the mud flats exposed by the retreating tide are coloured black or dark olive. *Ilyanassa obsoleta* has the shell black, while the soft parts are quite dark. A related form, *Nassa trivittata*, lives in more sandy places, and has a similarly coloured shell. *Rissoa minuta*, inhabiting mud flats, has a shell dark olive, or nearly black, while other species of *Rissoa* are much lighter in colour. The fronds of the large Laminarian are frequented by *Lacuna vincta* and its variety *fusca*. The first is greenish or purplish horn colour, with darker bands, while the variety *fusca* is uniformly dark brown or chestnut; the colours in both cases quite match the Laminarian upon which they are found. Another species of the same genus, *Lacuna neritoidea*, Mr. Fuller has observed spawning on bladder-weed, and its yellowish tinge accords well with its surroundings. *Margarita helicini* I have found in numbers on the large Laminarian, and on seaweed at low-water mark, and its colour is decidedly protective; while other species of *Margarita*, dredged in deep water on shelly ground, are whitish, pearly, or red.

The protective colouring of certain species is well seen upon stones dredged in deep water, the various mollusks adhering to them closely resembling the calcareous algæ and the stones themselves.

Species similar to sand beaches are of various sand-coloured shades, as for example *Machæra*, *Mactra*, *Cochlodesma*, *Cyprina*, the little *Solenomya*, and *Solen*. On muddy ground we notice certain *Tellinas* and other species with white shells. It has been supposed that those species hidden from the light were generally white, and this would seem to be the case when we recall *Mya*, certain species of *Teredo*, *Tellina*, *Pholas*, and other species. Yet we do have cases where the shell is oftentimes conspicuously banded or marked. It might appear that in those species living buried in the mud or sand, the shell was protected by a very thin epidermal layer, and that this layer was eroded, thus exposing the white shell; there are certain species, however, living buried in the mud or sand, which have an epidermal coat, very thick, and dark brown or black: such examples are seen in *Solenomya borealis* and *Glycymeris siliqua*.

It has been noticed that the same species occupying different stations are differently coloured. Dr. A. A. Gould noticed this in regard to *Astarte castanea*; those thrown up from deeper water are darker coloured than those found in quiet sandy places. In his "Report on the Invertebrate Animals of Massachusetts," first edition, p. 78, speaking of the shells found in the sandy harbour of Provincetown, he says: "The colour of all the shells in that harbour is remarkably light."

A very evident case of protective colouring is seen in the three species of *Crepidula* found on our coast. *Crepidula fornicata* is drab, variously rayed and mottled with brown, and it lives attached to stones near the roots of the large Laminarian, or upon stones clothed with algæ of similar colours, or attached to the large *Mytilus*. *Crepidula convexa*, a much smaller species, lives on the roots of seaweed. Prof. Perkins records its occurrence on the black shell of *Ilyanassa obsoleta*. This *Crepidula* has a very dark brown shell, according well with the dark colour of its various places of lodgment. *Crepidula plana* or *unguiformis* lives within the apertures of larger species of Gasteropods, as *Buccinum*, *Natica*, *Busycon*, and others. The shell of this *Crepidula* is absolutely white.

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* In an inlet near Salem the writer observed a school of minnows swimming along the bottom, and as they approached a certain point jumped right and left in great alarm. For some time the disturbing cause could not be found. On closer examination, however, a Cottus was seen to open his large mouth and take in several of the little fishes. The Cottus was so perfectly protected by its colours that it was only recognised when the capacious mouth opened, and only then were the minnows alarmed. Just beyond in their track was a rusty tin fruit can, the little tin remaining on it reflecting the rays of the sun, and from this harmless object they all turned affrightedly away. In this connection it would be interesting to inquire into the food of fishes in respect to their colours. Those fishes feeding upon Mollusca would certainly not require that protection for concealment as those living upon more active prey.

There are many species that undoubtedly receive protection in allowing foreign substances to grow upon their shells, and these species, oftentimes covered by a dense growth of calcareous or other algæ, are difficult of detection by the experienced collector.

There are also certain species that habitually accumulate foreign substances upon their shells. The little *Pisidium ferrugineum* possibly finds greater immunity from danger in its habit of accumulating a ferrugineous deposit on that portion of the shell most conspicuous. *Nucula delphinodonta* has likewise a similar habit. The delicate *Lyonsia arenosa*, with its habit of entangling particles of sand in its epidermal filaments, undoubtedly finds protection in this peculiarity.

It was not the intention to go outside of New England species in citing these examples, but in this connection I cannot forbear mentioning the tropical genus *Phorus*. The species are said to frequent rough bottoms, and to scramble over the ground, like the Strombs, and not to glide evenly. This peculiar manner of moving would render them very conspicuous, and it is curious to observe that most of the species attach foreign substances to the margins of their shells as they grow, so that when a shell has attained its growth, it is almost completely concealed by fragments of shells large and small, spines of Echini, bits of coral, and stones.

These few observations are offered (and they might be multiplied) with the belief that if there is any truth in the theory of protective colouring, as advanced by Wallace, the various colours of Mollusca in many cases can be explained, and the occurrence of varieties in colour are also accounted for by the same theory.

EDWARD S. MORSE

SCIENCE AT THE LONDON SCHOOL BOARD

PROF. J. J. SYLVESTER has issued his address as candidate for election to the London School Board for Marylebone in the room of Prof. Huxley. The importance of having at least one representative of Science on the Board induces us to print his Address in full. It must be obvious that many subjects will come before the Board wherein the opinion of a man of Prof. Sylvester's scientific training will be of the highest value; and we heartily wish the Board may be fortunate enough to obtain the additional strength which will be secured by his election.

"LADIES AND GENTLEMEN,—An influential body of ratepayers have appealed to me as a man of science, to offer my services on the London School Board.

"It has been represented to me, as the wish of your great constituency, that Prof. Huxley should be replaced by one who, like himself, has made the scientific part of education the chief business of his life. On this ground I have ventured to place myself in your hands.

"My University career at Cambridge, added to my experience both as Professor of Natural Philosophy at University College, London, and subsequently as Government Professor of Mathematics during a period of fifteen years at the Royal Military Academy at Woolwich (from which I have recently retired), have given me considerable knowledge of educational matters in England. My position as Corresponding Member of the Institute of France, as Corresponding Member of the Royal Academy of Science of Berlin, as Foreign Member of the Royal Academy of Science of Naples, and other learned corporations, gives me an early and accurate knowledge of what is passing in the chief intellectual centres of the Continent. I have ample leisure for the work that is to be done, not only in attending the ordinary meetings of the Board, but also the various sub-committees on which the general working of the Act devolves, as well as the divisional and district committees, on the efficiency of which the local benefit of that Act depends.

"If you send me to the London School Board, I shall be prepared, while looking forward to the gradual adoption of a National system of Education, to adhere to that wise and moderate compromise by which, without violation of principle, you may obtain the use of existing school machinery.

"I have the honour to be, Ladies and Gentlemen, your obedient servant,

"J. J. SYLVESTER, LL.D., F.R.S.

"Central Committee Room,
25, Great Quebec Street, Marylebone Road, W."

Dr. Sylvester has already received the promise of the support of the following scientific men:—Sir Chas. Wheatstone, D.C.L.; Prof. Sharpey (Sec. Royal Society); Prof. Busk, Pres. Royal Col. Surgeons; Phillip H. Calderon, R.A.; William Heywood, C.E.; E. H. Lawrence, F.S.A.; J. Norman Lockyer, F.R.S.; J. Gerstenberg, F.R.G.S.; J. Gwyn Jeffreys, F.R.S.; Nicholas Trübner, M.R.A.S.; Prof. T. Hewitt Key, F.R.S.; Dr. Wilson; David Forbes, F.R.S.; H. W. Bates, Sec. Royal Geog. Society; Henry Holiday; Henry Watts, F.R.S.; Dr. Pick; Thomas Woolner, A.R.A.; Professor Williamson, F.R.S.; Charles Brooke, F.R.S.; Sir Henry Thompson; Colonel Stuart Wortley; Dr. Forbes Winslow, F.R.S.; Joseph Durham, A.R.A.; C. Murchison, M.D., F.R.S.; Prof. Henry Charlton Bastian, F.R.S.; William Perkins; Noel Humphreys, F.S.A.; T. Spencer Cobbold, M.D., F.R.S.; A. W. Bennett, F.L.S.; Sir Julius Benedict; Prof. W. Warrington Smyth, F.R.S.; George Cruickshank; Prof. J. Percy, F.R.S.; George Harley, M.D., F.R.S.; Nevil S. Maskelyne, F.R.S.; W. S. Dallas, Sec. Geol. Soc.; Prof. G. C. Foster, F.R.S.; William Chaffers, F.S.A.; J. J. Stevenson, F.R.G.S.; and J. H. Pepper.

NOTES

WE congratulate the Science and Art Department on a resolution at which they have just arrived, in consequence of applications from science schools, to form collections of such specimens, models, diagrams, &c., as are best adapted for teaching the various branches of science which the Department aids by grants. It is proposed that collections shall be sent on loan for short periods to the local schools, to assist them in furnishing themselves with the necessary apparatus. The specimens and apparatus already in the Educational Department of the South Kensington Museum have been arranged for examination under the different subjects of instruction, and a letter has been forwarded to all the Examiners of the Department, requesting them to inspect the collections, with the view of advising what portion of them they consider may with advantage form part of the proposed travelling collections; what additions should be made, so as to give the science schools an idea of what they would require for a complete outfit; and what are the best and cheapest forms of apparatus, &c., for them to provide themselves with.

A FEW months ago we noticed the expedition to Moab which, by the aid of the British Association, was organised by Dr. Ginsburg and Dr. Tristram. We have now to announce the safe return of Dr. Ginsburg, and hope soon to be able to state some of the results of the expedition, which we have reason to believe are both numerous and interesting.

THE Society for the Encouragement of Arts, Manufactures, and Commerce is about to organise examinations in the science and technology of the various arts and manufactures of this country, which shall be conducted by a Board of Examiners, capable of testing the practical knowledge and skill required in the application of the scientific principles involved in each art or